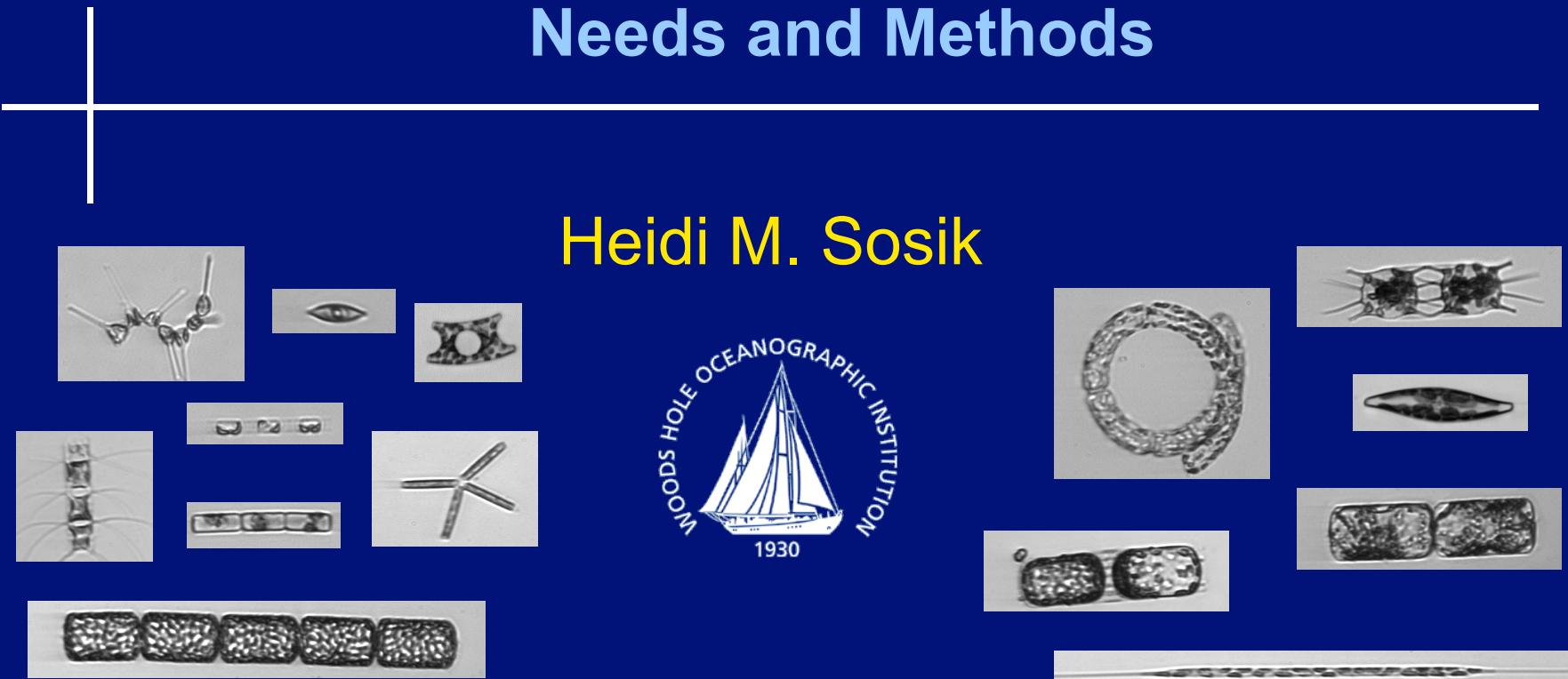


Ocean Observing for Plankton: Needs and Methods



OceanObs RCN meeting

San Francisco, CA 13 December 2015

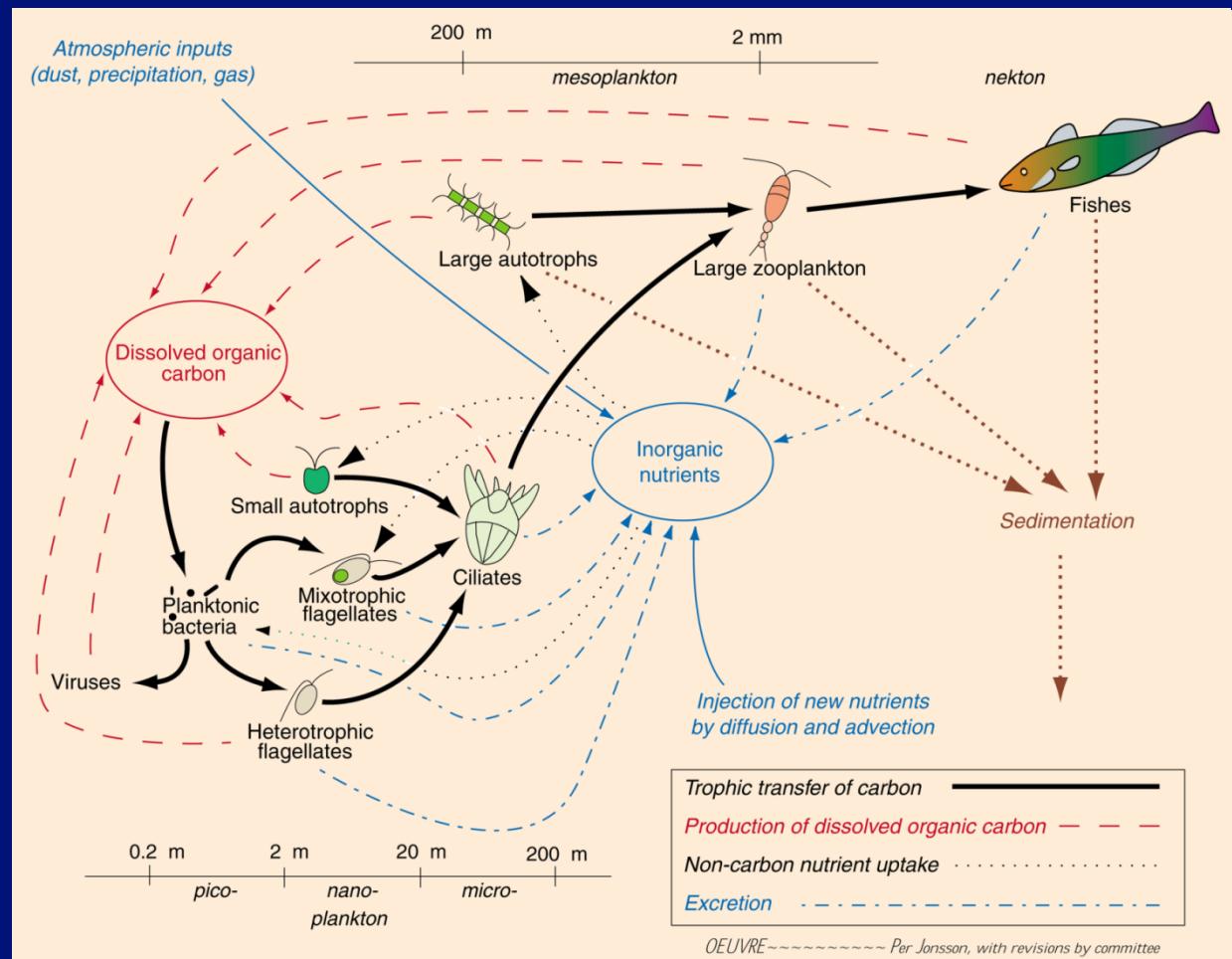
Classic problems in plankton ecology

How are communities structured?

How does this impact function?

How do structure and function vary in space and time?

Context of change in environment and climate



Observational demands

multidisciplinary sustained high resolution
- space, time, taxa

Needs - Observational Challenges

Resolution

- Taxonomic
- Temporal
- Spatial

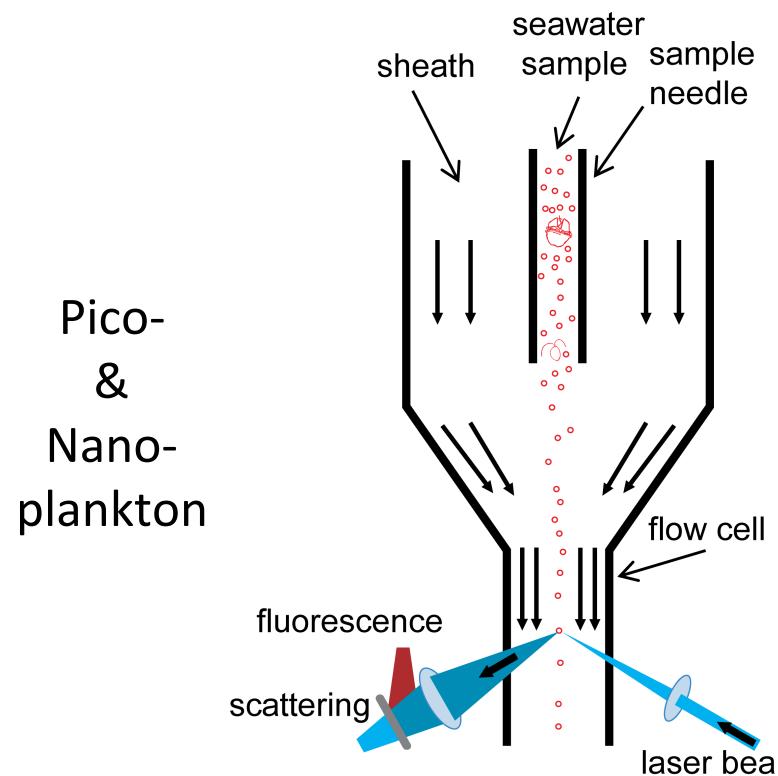
Dynamic Range

- Organism size: $>10^4$ in length, microns to millimeters
- Organism concentration: $>10^{10}$, μl^{-1} to m^{-3}
- Time scales: $>10^7$, minutes to decades
- Spatial scales: $>10^5$, cm to basins

→ Demands multiple instrument designs

Flow Cytometry

Conventional



Sosik et al. 2014

Single cell, typical measurements:

Chlorophyll fluorescence

Light scattering (forward, side angle)

Phycoerythrin fluorescence

Phytoplankton Time Series at MVCO

Martha's Vineyard Coastal Observatory (MVCO)
Cabled site with power and two-way communications

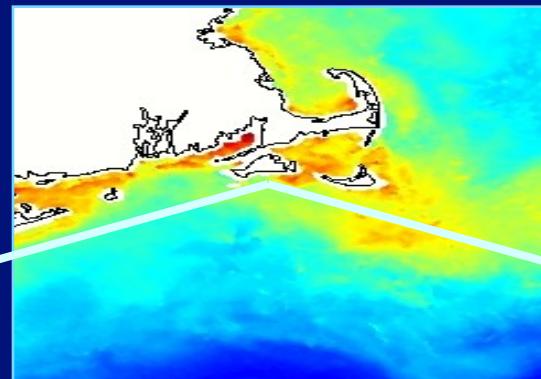


Picoplankton



FlowCytobot

Olson et al. 2003
Sosik et al. 2003



Microplankton



Imaging
FlowCytobot

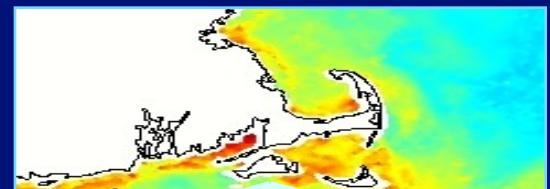
Automated features for extended deployment

Standard analysis, biofouling control, real time humidity sensing & intake valve control

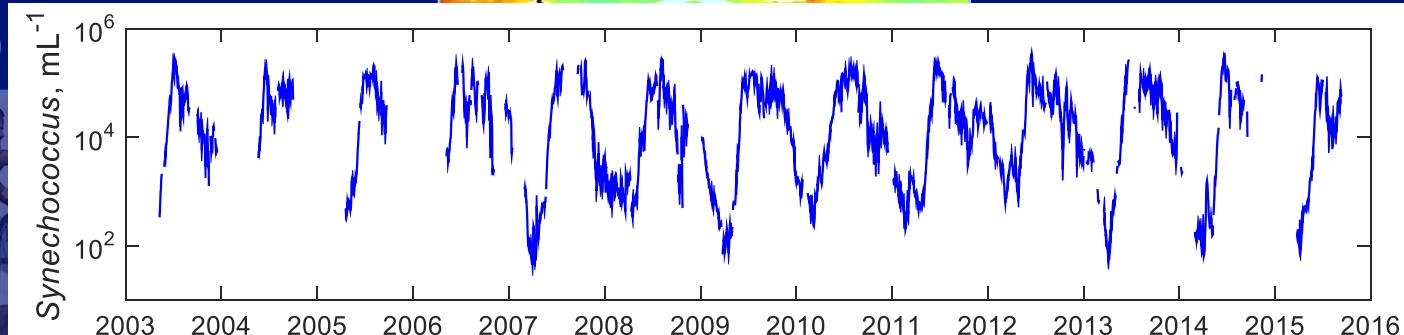
Olson and Sosik 2007
Sosik and Olson 2007

Phytoplankton Time Series at MVCO

Martha's Vineyard Coastal Observatory (MVCO)
Cabled site with power and two-way communications

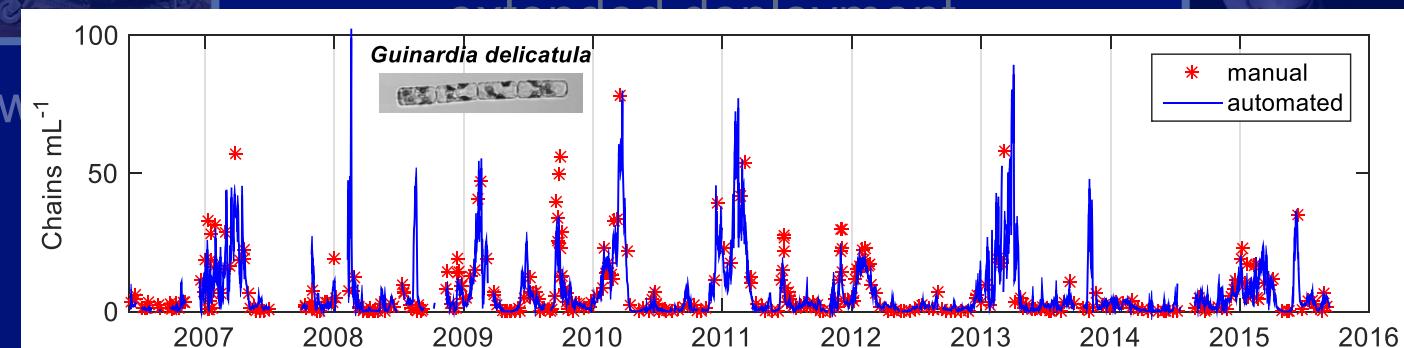


Picop



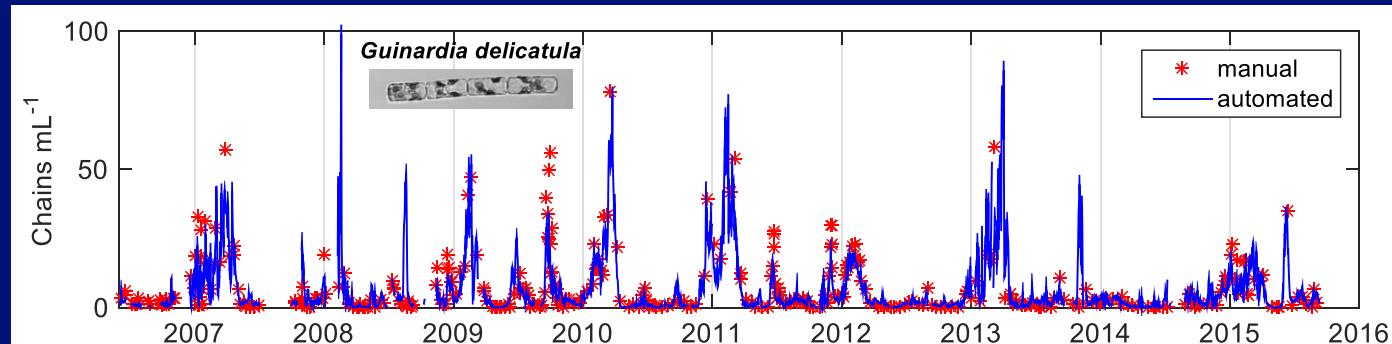
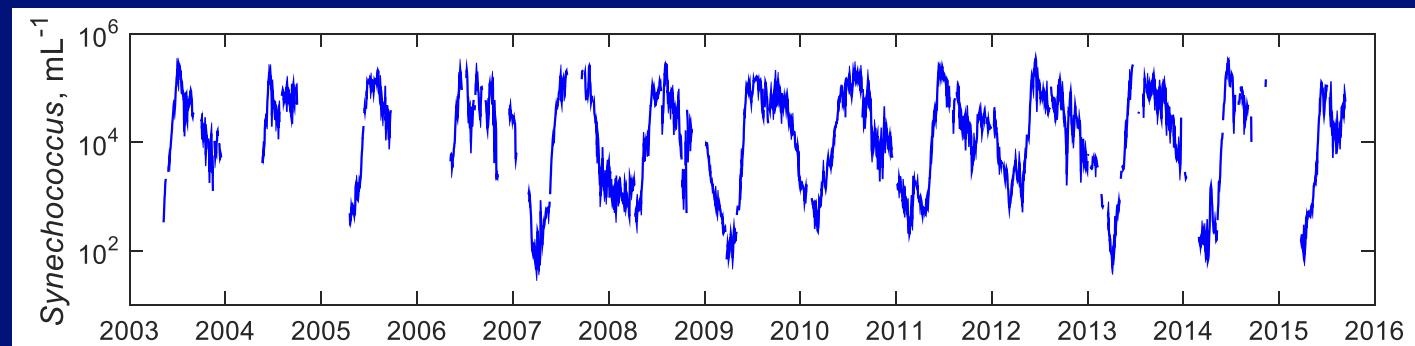
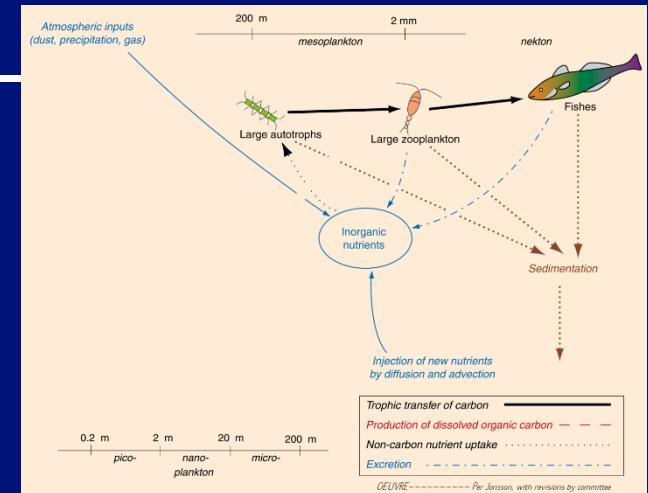
ankton

Flow



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Phytoplankton Time Series at MVCO



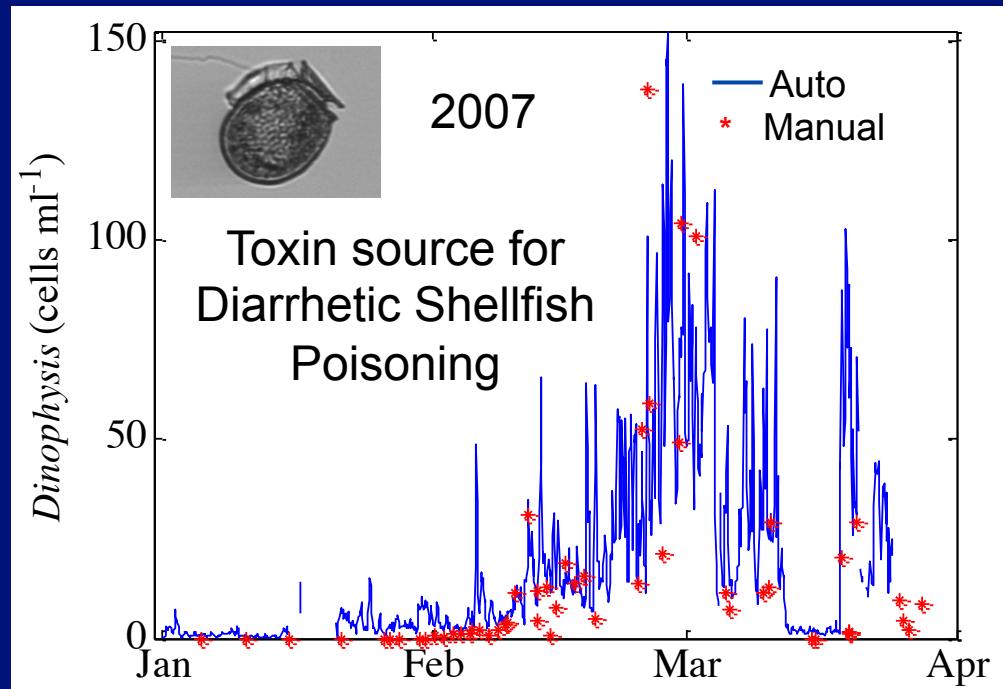
Novel approach for mitigating harmful algal blooms



Imaging FlowCytobot
early warning for
unprecedented event
along Texas coast

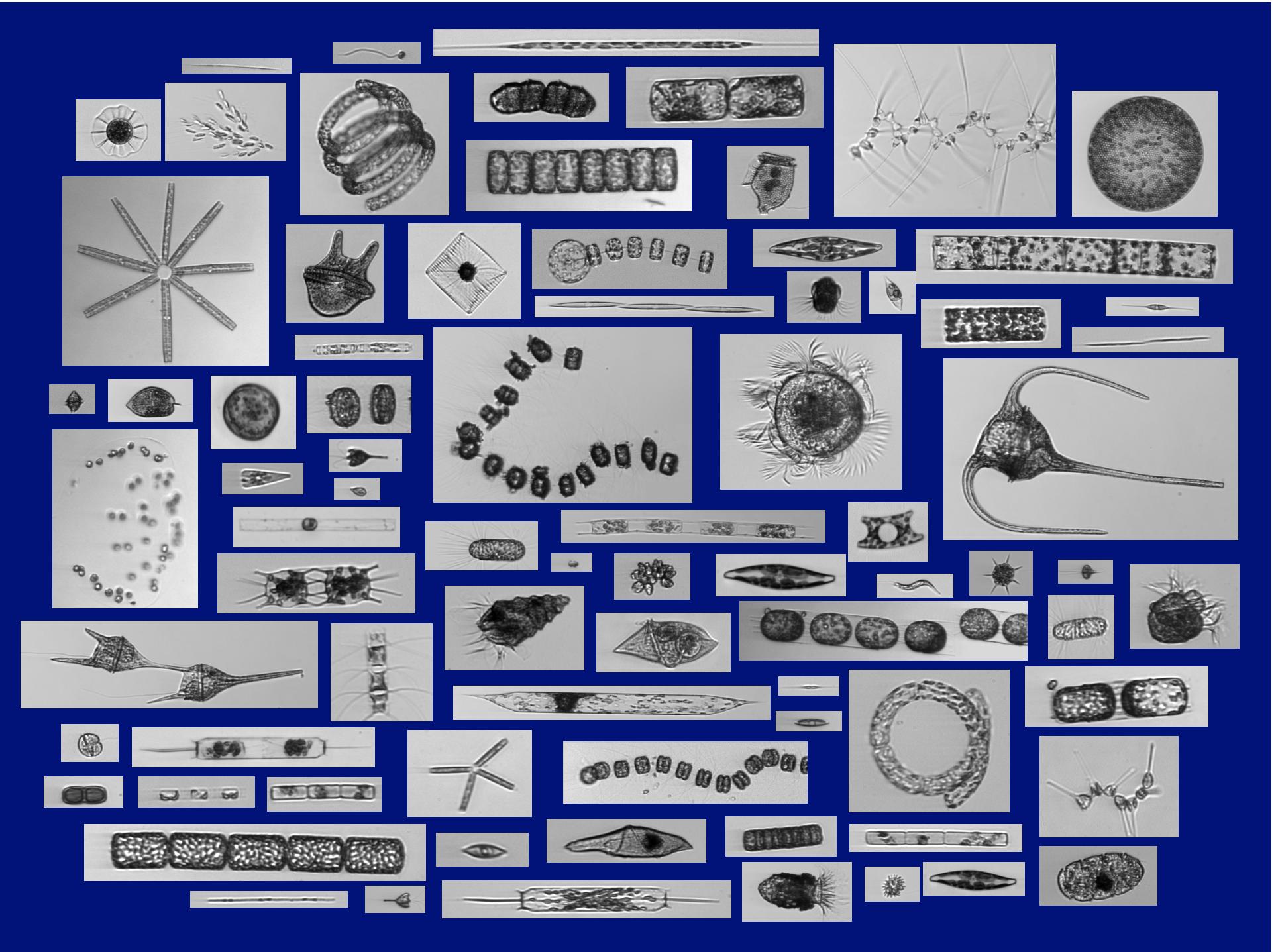


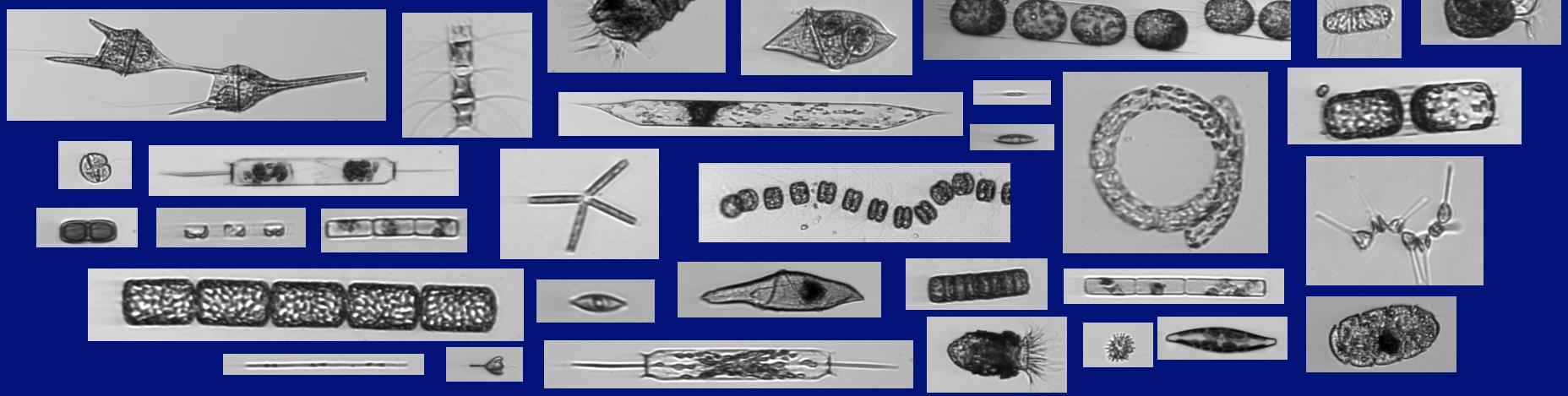
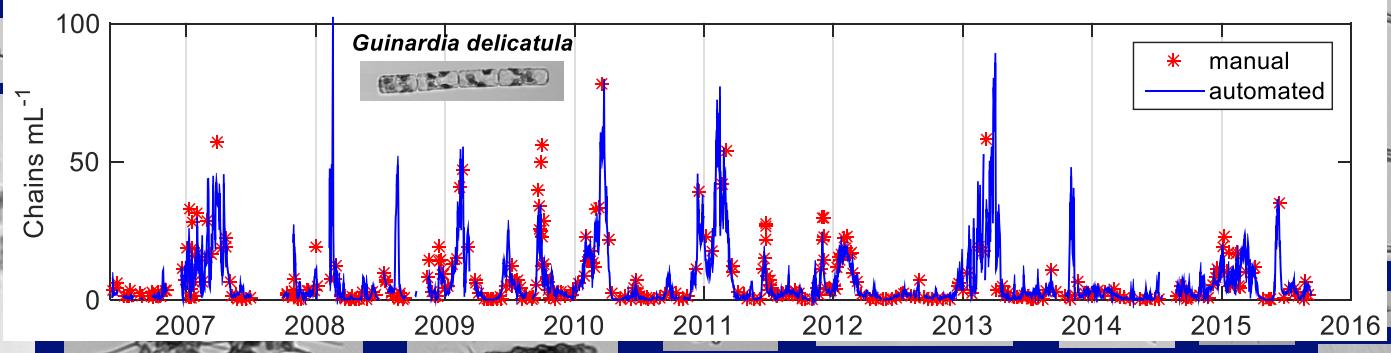
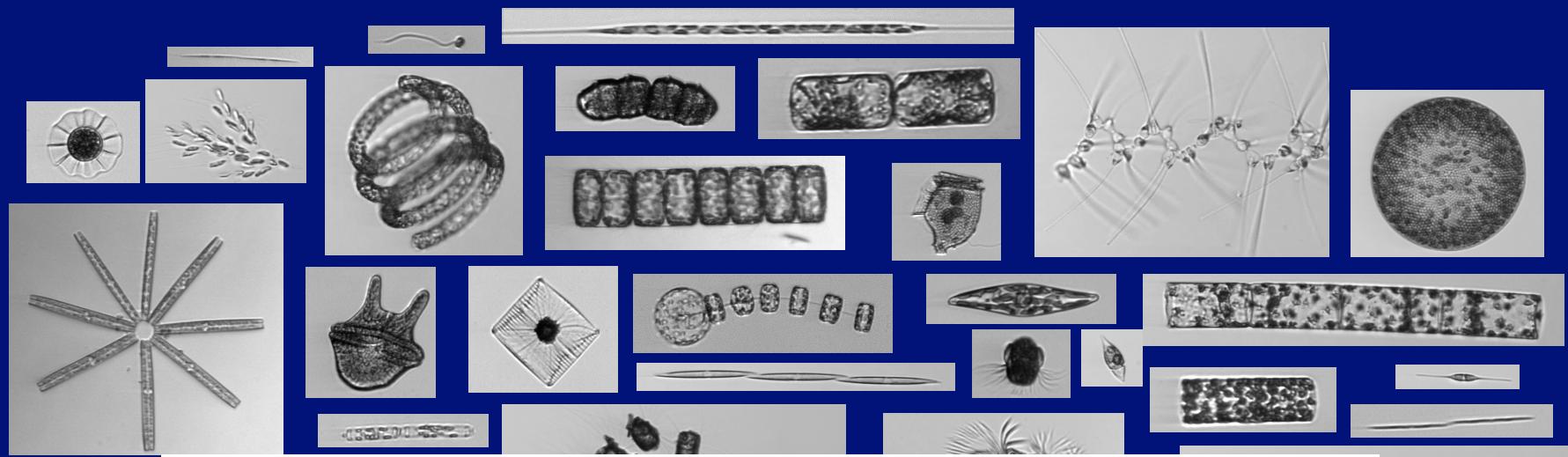
Shellfish
recalled & harvest
closed within days



→ Human health protected

Campbell et al. 2010

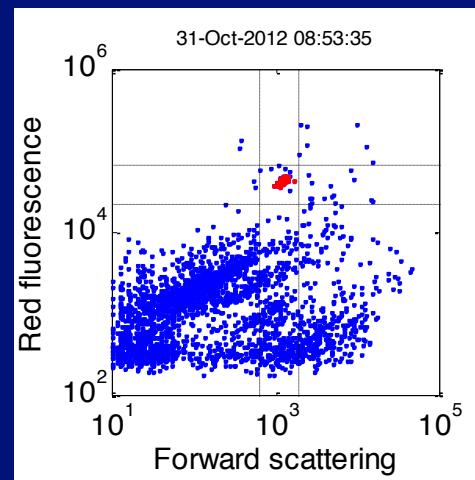
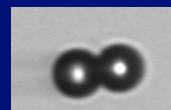
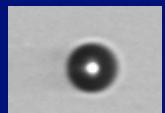




Needs - Observational Challenges

Logistics / Operations

- Biofouling control
- Redundancies
- In situ standard analysis



Fluorescent microspheres

Internal reservoir

Automated analysis as “sample”



Multi-pronged approach

- Protect intake
- Protect optical surface
- Protect fluidics system



Two identical pumps
one in reserve

Needs - Observational Challenges

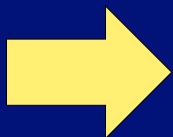
Logistics / Operations

- Biofouling control
 - Redundancies
 - In situ standard analysis
-
- Instrument size
 - Power
 - Bandwidth / storage

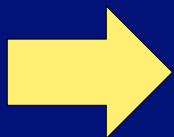
IFCB - From Prototype to Product



Original
prototype



Optimized
design

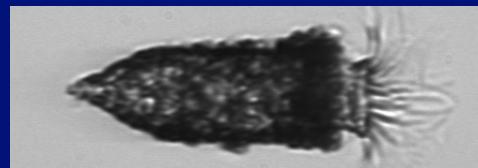
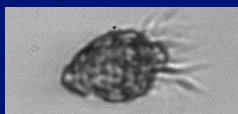


Commercial
unit

IFCB New Developments

Staining IFCB

- enhanced detection of protozoan taxa
- automated live cell staining,
targeting micrograzers



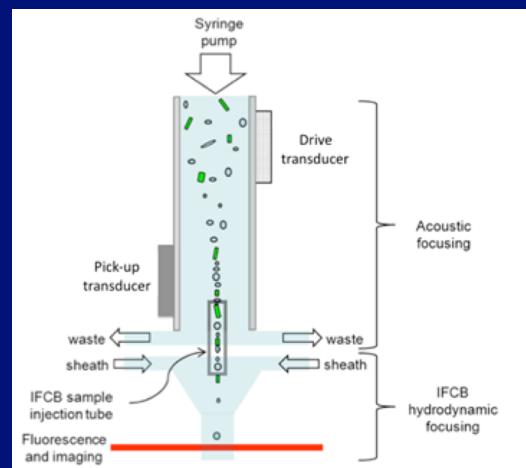
IFCB for autonomous surface vehicles

- enable spatial sampling



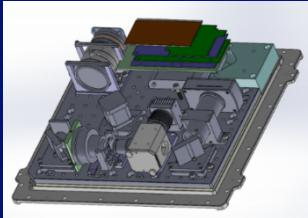
High Throughput IFCB

- enhanced sampling statistics
- acoustic focusing,
pre-concentration of
cells above flow cell



An Autonomous Oceanic Microscope

Near-real time phytoplankton observations from a Wave Glider



- ▶ Unmanned, mobile, low-power
- ▶ Geo-tagged near-real time imagery of microscopic surface water communities
- ▶ Delivery of images via 3G/4G cellular modem where available, on-board storage if not.
- ▶ Coexistence/collaboration with other scientific instrumentation and payloads.
- ▶ Field testing: Bright Field, Olympus 4X, resolution limit 2.3 μm
- ▶ In very early R&D: 10x objective (1 μm resolution), Fluorescent incident illumination & Dark Field



Beyond microplankton - CPICS

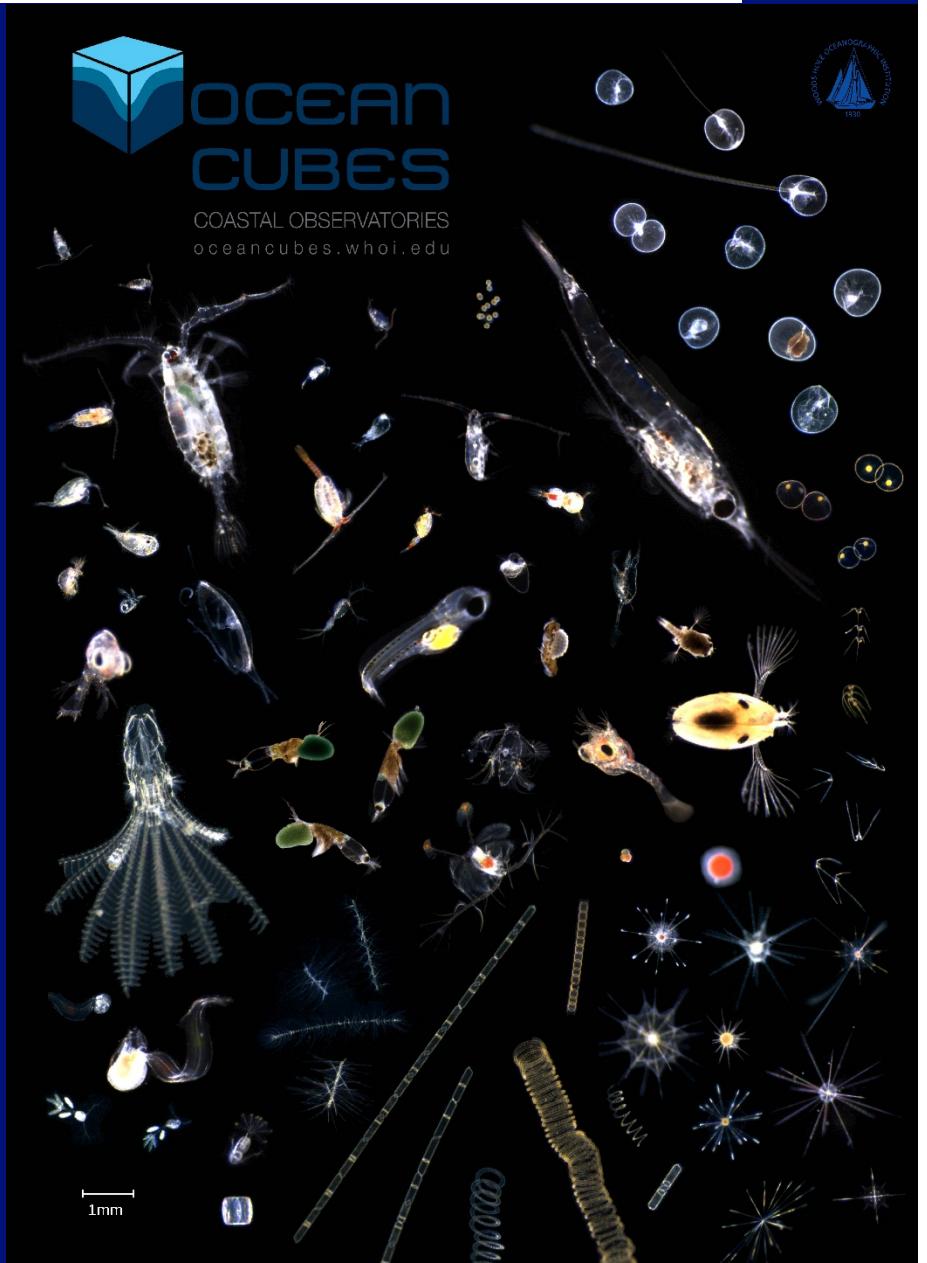
“Continuous Particle Imaging
and Classification System”



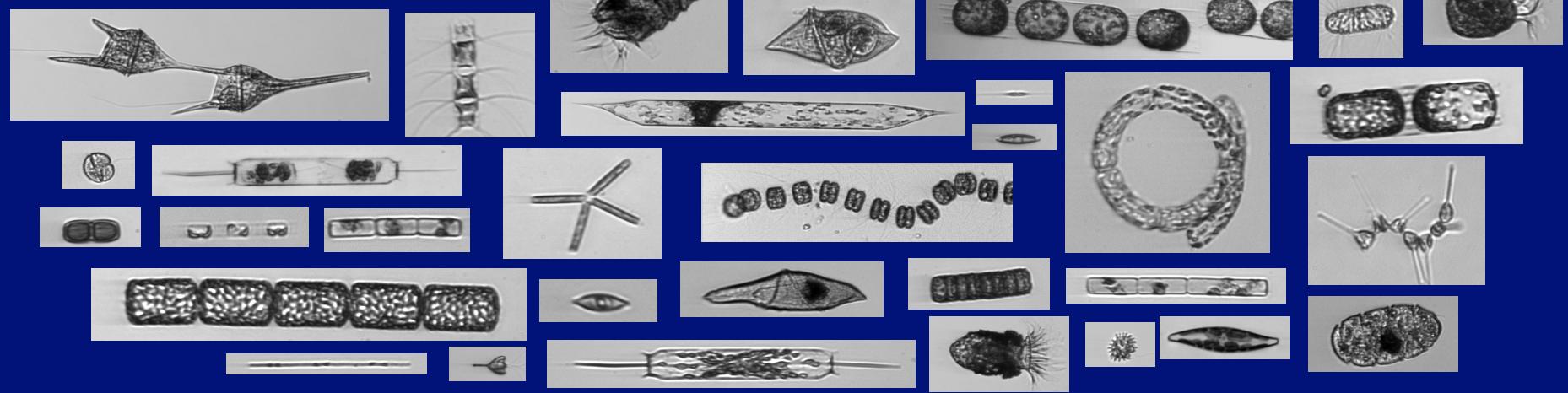
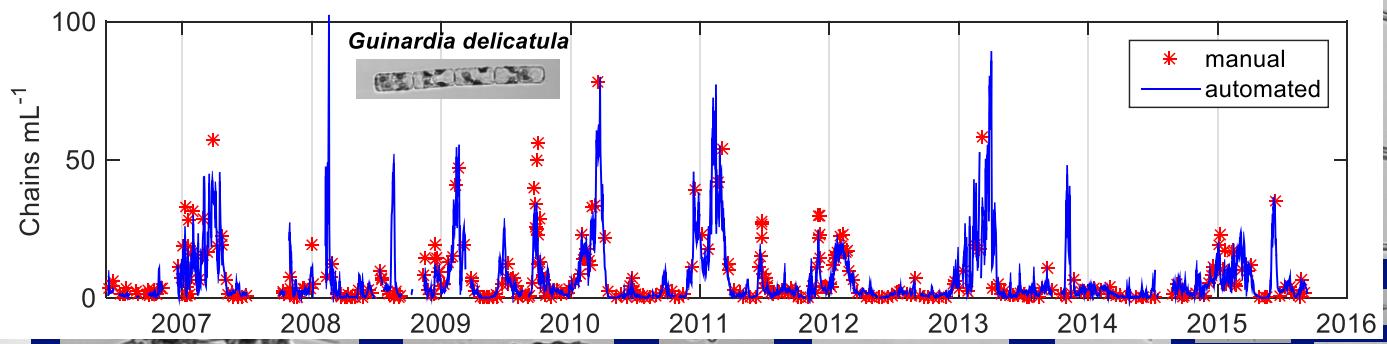
Extend to millimeter size range

Target mesozooplankton
and planktonic larvae

OceanCubes observatories
<http://oceancubes.whoi.edu/>
Gallager et al.



Big Data



Pressing Need for Information Management

IFCB Dashboard

<http://ifcb-data.whoi.edu/>

Open data
access

Standard
formats

Processing
pipelines

End-to-end
provenance

Shared code



Needs and Status Summary

Resolution / Dynamic Range

- Taxonomic
- Temporal
- Spatial

Informatics

- Data and product access
- Analysis and product workflows

Logistics / Operations

- Biofouling control
- Redundancies
- In situ standard analysis
- Instrument size, power, and bandwidth

Acknowledgments: Rob Olson, Joe Futrelle, Lisa Campbell, Emily Peacock, Taylor Crockford, Alexi Shalapyonok, Emily Brownlee, Scott Gallager, Jupiter Research Foundation

